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WESTERN SPRUCE BUDWORM ON
PROPOSED ANALYSIS UNITS
UMATILLA NATIONAL FOREST



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INTRODUCTION

The outbreak of western spruce budworm (WSBW), Choristoneura occidentalis, has continued to cause defoliation on the Walla Walla Ranger District of the Umatilla National Forest, and has once again prompted an analysis to determine the need for budworm suppression. Geographical areas with resources that have a potential for being adversely affected were delineated into Analysis Units (AU). A biological evaluation was conducted in these Units to determine: (1) the level of damage that has already occurred, and (2) predict the additional damage that will occur in 1991.

Initially, four AU's were identified. These were the Mill, Jubilee, Meacham, and Thimbleberry Units. Figures 1 and 2 show the proposed Meacham and Thimbleberry AU's.

This report summarizes the budworm population and tree damage data collected from these AU's during summer and fall of 1990. In addition, this report presents recommendations based on these data, combined with aerial survey information, ground observations, and general knowledge of the areas.

BACKGROUND AND HISTORICAL INFORMATION

The western spruce budworm is a native insect whose populations periodically reach outbreak numbers. While these outbreaks are natural events, they may occasionally cause damage which conflicts with our resource objectives. The budworm has a 1-year life cycle. The destructive stage of the insect is the larval stage, which mines in the buds and feeds on the current year's foliage of host trees, primarily Douglas-fir and true firs. As the spring and summer progress, the damaged needles turn red and the trees within the infested area take on a reddish appearance. Repeated heavy defoliation of the new growth can result in growth loss and top-kill, and in some cases, tree mortality.

The WSBW outbreak on the Walla Walla Ranger District was first reported on 730 acres during the annual aerial detection survey in 1984. The number of acres defoliated, continued to increase in 1985 and 1986. In 1987, the largest number of acres of defoliation (269,750) were reported.

Portions of the proposed Meacham AU were treated in 1988, during a Pilot Project evaluating different formulations of the biological insecticide, Bacillus thuringiensis. Other portions of the Unit were left untreated to serve as check areas for the Project.

In 1989, the number of defoliated acres decreased to 101,223 acres. This decrease was due, in part to the subsequent foliage protection from the treatment the previous year. Acres defoliated increased only slightly in 1990 to 117,772 acres.

Table 1 shows the amount and intensity of defoliation reported by the aerial detection survey, for the Walla Walla RD from 1984 through 1990. The majority of defoliation has consistently remained in the light category. About 10 percent of the area experienced moderate defoliation in 1990, with the majority of those acres occurring outside of the proposed AU's.

Over the past several years, the Blue Mountains of Oregon and Washington have begun to exhibit the combined impact of a variety of insect, disease, and climatic stresses. In addition to the budworm defoliation, trees in this area have been subjected to stress caused by several consecutive years of drought. Tree mortality caused by bark beetles attacking drought-stressed trees has increased dramatically throughout the Region, including this area in the Blue Mountains. Bark beetles include the western pine beetle, Dendroctonus brevicomis, on ponderosa pine; the fir engraver, Scolytis ventralis, on true firs; and The Douglas-fir beetle, D. pseudotsugae, on Douglas-fir. The Douglas-fir tussock moth (DFTM), Orgyia pseudotsugata, populations have also begun to increase in parts of the Blue Mountains. The DFTM larvae also feed on the foliage of true firs and Douglas-fir.

METHODS

ANALYSIS UNIT CHARACTERISTICS

During the summer of 1990, western spruce budworm sampling was conducted in the Thimbleberry, Mill, Jubilee, and Meacham Analysis Units. Stands in these units are comprised of multi-storied mixed conifer, with mostly Douglas-fir, grand fir, and minor components of western larch in the overstory, and Douglas-fir and grand fir in the understory. Occasional pockets of ponderosa pine occur at lower elevations and sub-alpine fir, Engelmann spruce and lodgepole pine are present at the higher elevations.

SAMPLING DESIGN AND PROCEDURES

Sampling consisted of three phases: lower and midcrown larval sampling, adult moth trapping, and stand evaluation.

Larval sampling

The larval sampling is used as the first indicator of the WSBW population and is used principally to determine which Units have population levels that warrant further evaluation. Units with low larval populations would be eliminated from any additional evaluation.

Budworm larval population densities were determined in the AU's from lower crown beating samples. Thirty plots were established in each AU, except Meacham. Plots were randomly established to represent the Analysis Unit's geographical and elevational characteristics. All sampling plots were located along forest road systems, but away from the road at least 200 feet to avoid road dust.

Two hundred twenty-five plots established during the 1988 Meacham Pilot Project (USDA 1988) were used for sampling points within the Meacham AU.

Sampling was conducted according to the method developed by Mason, et al. (1989) for lower crown beating. Sample trees were WSB host trees (Douglas-fir and grand fir) having branches with new shoots that could easily be reached from the ground. Lower crown sampling involved beating the apical 18-inch tip of three lateral branches, from the lower crown third, from five trees over a beating cloth stretched over an aluminum frame (Paul 1979). The total number of larvae on the three branches was counted and the average per sample tree determined.

Pheromone trapping

The second phase of sampling consisted of trapping adult WSBW moths using traps baited with WSBW pheromone. On June 10 and 11, pheromone traps (one trap per site) were placed at 30 sites within the Thimbleberry AU, and 27 sites within the Meacham AU. In the Thimbleberry AU, pheromone traps were placed at the locations where larval population information was collected. In the Meacham AU, traps were placed at 3 sites in each of the nine treatment blocks established during the 1988 Meacham Pilot Project.

Milk-carton type traps which have a tent-like configuration and sticky interiors, were placed on host trees at each site. The pheromone used was a 92:8 blend of (E)-11 and (Z)-11 tetradecenal. All baits were 3- by 5-mm polyvinyl chloride pellets impregnated with the pheromone at a strength of 0.0001 percent pheromone by bait weight. One pellet was placed on a pin and attached to the inside of the trap. Care was used so that pellets did not touch the sticky substance.

Pheromone traps were collected approximately 6 weeks later. Traps were examined in the field at the time of collection and the number of moths per trap were counted.

Stand characteristics

The third phase was concerned with effects of the WSBW on trees. At each of the pheromone trap sites a 20 BAF variable radius (for trees >2.9-in. DBH) and a 1/300 acre fixed-radius plot (for trees <3-in DBH) were established. Information collected at these sites included site characteristics (slope, aspect, location, elevation) and tree characteristics (species, crown ratio, crown class, bare top, current and cumulative defoliation levels, and DBH). Crown ratio, bare top, current and cumulative defoliation were not collected for fixed plot trees. The stand examination was completed during August.

RESULTS

Larval sampling

Larval populations based on lower crown beating averaged 22.38 larvae per tree on the Meacham AU, 22.43 larvae per tree on the Thimbleberry AU, 2.17 larvae per tree on the Jubilee AU, and 0.69 larvae per tree on the Mill AU. (Table 2). A population of eight or more larvae per tree was used as a threshold for continued evaluation using pheromone traps. Using this criteria, the Jubilee and Mill Units were dropped from further biological evaluation.

Pheromone Trapping

Pheromone trap catches averaged 27.33 moths/trap on the Meacham AU and 25.16 on the Thimbleberry AU (Table 4). Moths caught per trap, and the predicted defoliation for the subsequent year have been estimated (Charles Sartwell, USDA Forest Service, PNW Experiment Station, personal communication) to be as follows:

- 0-4 = defoliation undetectable by cursory observation;
- 5-19 = patchy defoliation within some trees;
- 20-34 = most trees lightly defoliated;
- 35-44 = stand moderately defoliated;
- 45-55 = heavy defoliation of upper crowns;
- >55 = heavy defoliation of entire crowns.

There is some uncertainty associated with predicting the defoliation caused by the larvae of one budworm generation from estimates of pheromone trap catches in the previous generation, however, it is the best method available. Several data sets have shown a good correlation between these two variables. Subsequent changes in AU boundaries resulted in only 25 plots being located in Thimbleberry, and 9 in Meacham. Based on this prediction scheme, light defoliation is predicted for the Thimbleberry AU, and light to moderate defoliation is predicted for the Meacham AU (Table 4). The low number of plots sampled, and the associated high standard error of the mean, on Meacham AU give us a lower confidence in this estimate of 1991 populations.

Stand characteristics

Bare top data (Table 5), indicate that some of the trees in both AU's may be experiencing minor top-kill, but no mortality of budworm host trees.

The percent cumulative defoliation (i.e., percent missing foliage) is a product of severity of defoliation and number of years that defoliation has occurred (Table 6). In the Thimbleberry AU, 1 percent of the host trees has experienced heavy cumulative defoliation, and 12 percent has experienced cumulative moderate defoliation.

The percent current defoliation (i.e., percent of this year's foliage that is missing) is recorded in Table 7. The highest percentage of trees with heavy defoliation was in the Thimbleberry AU with 69 percent of the host trees experiencing heavy current year defoliation. In the Meacham AU, 53 percent of the host trees experienced current heavy defoliation.

DISCUSSION AND RECOMMENDATIONS

A brief discussion of each AU that is being considered formally in the current environmental analysis follows. Refer to Tables 2-6 for specific trap catch, bare top, and defoliation estimates, percent of budworm host tree species, and numbers of plots sampled. Any reference to percent of trees in a category is referring to the percent of trees per acre, as calculated from variable plot data.

THIMBLEBERRY

Pheromone trap catches predict light defoliation for 1991. No bare tops were observed on 55% of trees with 34% exhibiting bare tops of less than 10% of total tree height. The plot trees that had died during the current outbreak were influenced by other factors, such as broken tops and root disease and probably did not die as a direct result of budworm defoliation. About 87% the trees exhibited none or light cumulative defoliation with 12% rated as moderate and 1% rated as heavy. Current defoliation was rated as heavy on 70% of the host trees with 6% in the "none" category. Defoliation has been evident at plot sites for 3 to 6 years.

Recommendations for 1991: No direct suppression; gather larval population density information in June using lower crown sampling techniques; do more intensive tree damage data collection and pheromone trapping if warranted by larval data; monitor through annual aerial detection survey conducted by FPM. If populations and management objectives warrant, reevaluate analysis for 1992.

MEACHAM

Pheromone trap catches predict light to moderate defoliation for 1991. No bare tops were observed on 69% of trees with 27% exhibiting bare tops of less than 10% of total tree height. The plot trees that had died during the current outbreak were influenced by other factors such as broken tops and root disease and probably did not die as a direct result of budworm defoliation. About 80% of the trees exhibited none or light cumulative defoliation with 20% rated as moderate and none rated as heavy. Current defoliation was rated as heavy on 53% of the host trees with 40% in the "none" to "light" category. Defoliation has been evident at plot sites for 3 to 6 years.

Recommendations for 1991: No direct suppression; gather larval population density information in June using lower crown sampling techniques; do more intensive tree damage data collection and pheromone trapping if warranted by larval data; monitor through annual aerial detection survey conducted by FPM. If populations and management objectives warrant, reevaluate analysis for 1992.

No direct suppression, but continued population monitoring, is recommended for both the Thimbleberry and Meacham AU's for 1991. This recommendation is made with the following considerations:

1. Application of pesticides to suppress western spruce budworm is a short term management tactic to minimize damage to host stands until other management actions can be employed which change the conditions making the stands less vulnerable to damage. Recent research indicates that budworm populations could rebound to prespray levels within two to three years (Torgersen, In Press). In areas where no management activities are planned that would change the stand characteristics to lessen the vulnerability to damage by spruce budworm, we do not recommend the use of pesticides for budworm population suppression and damage limitation. Continued feeding will allow the budworm to fulfill its natural role in forest stand dynamics. Future stands should be less vulnerable to future damage.
2. Direct suppression should be done in only those areas where the significant adverse effects on the resources nad management objectives should damage increase in the future. Budworm population and tree damage sampling should be intensified in 1991 areas where management objectives warrant if future consideration for treatment is anticipated.
3. Much of the Region, including the Blue Mountains, has experienced several years of drought, which has increased tree susceptibility to bark beetles. Mortality from bark beetles has increased throughout the Region, in pines, as well as Douglas-fir and true firs, and in both defoliated and nondefoliated areas. There is no indication that, should the drought continue, foliage protection through direct suppression, would decrease the susceptibility of the host trees to bark beetle attack. If an objective is to reduce the impact of bark beetles, then an evaluation, and subsequent management recommendations, for those insects should be conducted.
4. Plot data for both AU's indicate that although current year defoliation was moderate to heavy, overall cumulative defoliation is light, with few bare tops.
5. The area of budworm defoliation detected by the aerial survey in Northeastern Oregon increased from 1989 to 1990. This was mainly due to resurgence of budworm populations in areas where previous feeding has declined. Defoliation on the Walla Walla RD was first detected on 730 acres in 1984. Defoliation has been recorded during the aerial detection surveys through 1990; however, according to the detection surveys the majority of defoliation has consistently remained in the Code 1 category (Table 1). Defoliation in Code 2 and 3 categories occurs in scattered patches, primarily outside of the current AU's.

Table 1: Acres of western spruce budworm defoliation by year and code class for the Walla Walla Ranger District, Umatilla NF, 1984-1990.

	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989*</u>	<u>1990</u>
Code 1	730	25,150	133,310	268,740	214,915	93,775	105,260
2			950	860	1,240	7,066	12,145
3				150		382	337
Total	730	25,150	134,260	269,750	216,155	101,223	117,732

code 1 - current defoliation visible from the air

code 2 - current defoliation with some bare crowns (very little gray) still a lot of green foliage on trees.

code 3 - current defoliation with a lot of bare crown visible (somewhat gray in color, yet some green foliage on trees).

* Decrease accounted for in part, because Meacham Unit was treated in 1988 and there was almost no defoliation in treated areas in 1989.

Table 2. Average numbers of larvae per tree from lower crown beating plots in Umatilla National Forest, 1990.

<u>Analysis Unit</u>	<u>No. of Plots</u>	<u>Average Number Larvae/tree</u>
Thimbleberry	25	22.43 $\pm$ 3.22
Meacham	78	22.38 $\pm$ 1.49
Mill	30	0.69 $\pm$ 0.13
Jubilee	30	2.17 $\pm$ 0.43

Table 3. Analysis Unit names, land manager, and type of data collected, 1990 western spruce budworm biological evaluation, Umatilla National Forest.

<u>Land Manager</u>	<u>Analysis Unit</u>	<u>Pheromone Trap</u>	<u>Tree data</u>
Umatilla NF	*Thimbleberry	Y	Y
	*Meacham	Y	Y
	Mill	N	N
	Jubilee	N	N

* Analysis Units which are being considered formally in the environmental analysis are preceded by an asterisk.

Table 4. Average numbers of western spruce budworm adults per pheromone trap captured in Umatilla National Forest, 1990.

Analysis Unit	No. of Traps	Adults per Trap	Predicted 1991 Defoliation ^{1/}
Thimbleberry	25	25.16 $\pm$ 2.48	L
Meacham	9	27.33 $\pm$ 12.58	L to M

^{1/} L = most trees lightly defoliated

Table 5. Percent host trees/acre that are green, have 1-10% bare top, have >10% bare top, and are dead, 1990 western spruce budworm biological evaluation, Umatilla National Forest.

Analysis Unit	Green	1-10% Bare Top	>10% Bare Top	Dead
Thimbleberry	54	35	2	8
Meacham	70	27	2	0

Table 6. Percent host trees/acre by missing foliage (i.e., total cumulative defoliation) class, 1990 western spruce budworm biological evaluation, Umatilla National Forest.

Analysis Unit	None	Light	Moderate	Heavy
Thimbleberry	12	75	12	1
Meacham	30	50	20	0

LIGHT = >0<25%

MODERATE = >25%<50%

HEAVY = >50%

Table 7. Percent host trees/acre by current defoliation class, 1990 western spruce budworm biological evaluation, Umatilla National Forest.

Analysis Unit	None	Light	Moderate	Heavy
Thimbleberry	6	9	16	69
Meacham	2	38	7	53

LIGHT = $>0 \leq 25\%$

MODERATE = $>25 \leq 50\%$

HEAVY = $>50\%$

Figure 1. Thimbleberry Analysis Unit on Umatilla National Forest

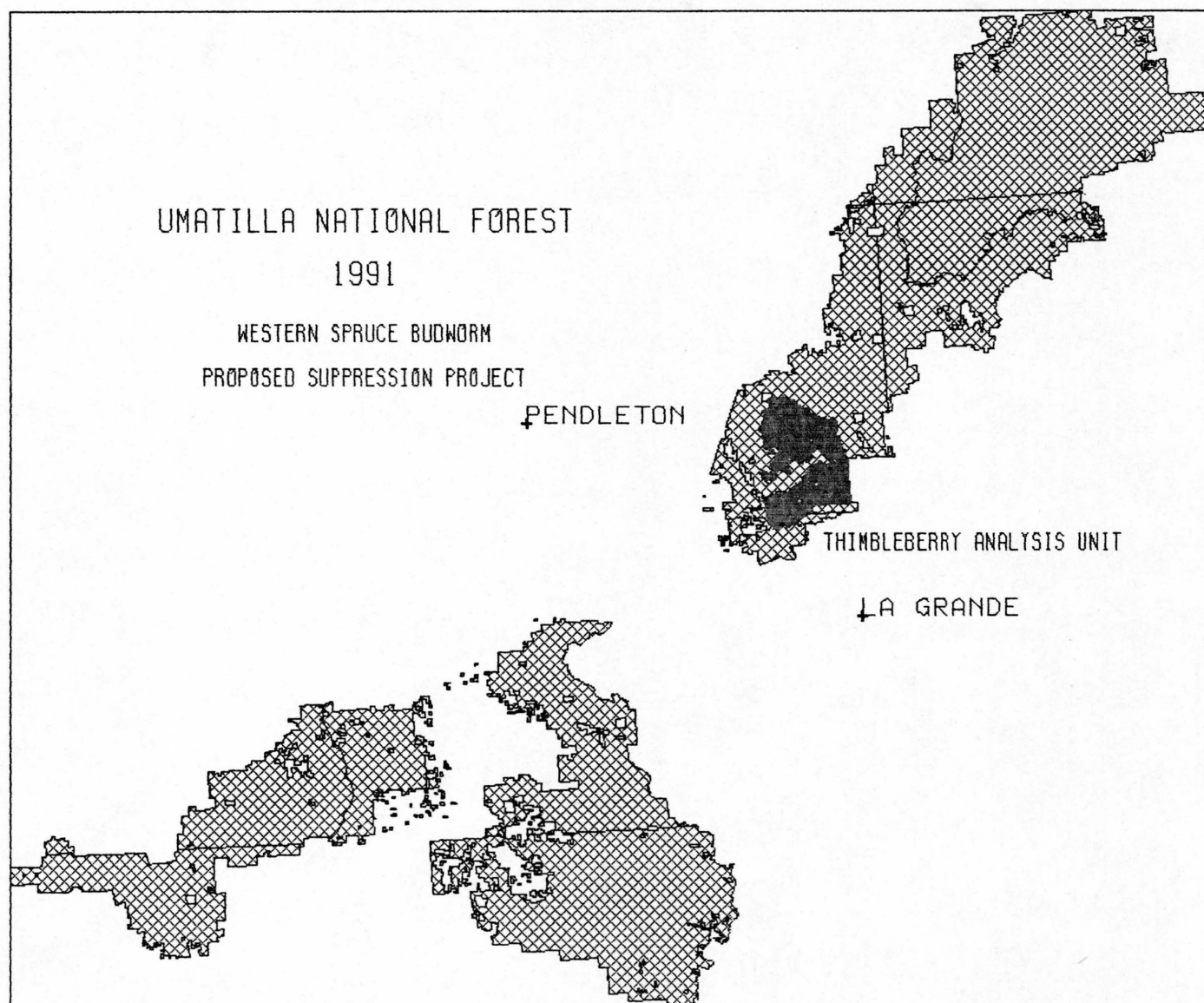
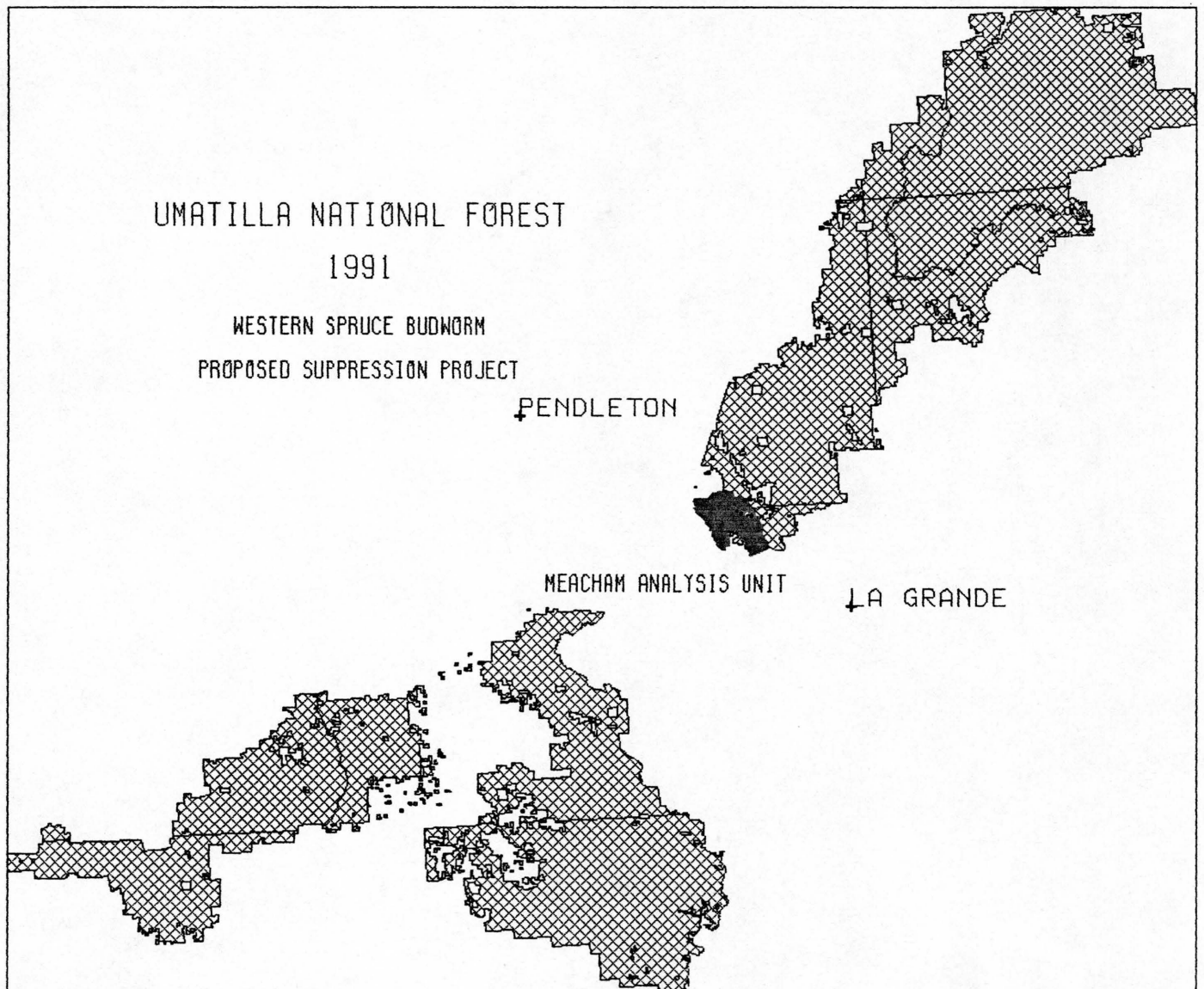


Figure 2. Meacham Analysis Unit on Umatilla National Forest



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References

- Paul, H.G.
1979. How to construct larval sampling equipment. U.S. Dep. Agric., Agric. Handb. 545. 11p.
- Hostetler, B.B.
1990. Western spruce budworm sampling guidelines for purposed 1991 Analysis Units. 16p. On file at: U.S. Department of Agriculture, Forest Service, Forest Pest Management, Portland, OR.
- Mason, R.R.
1979. How to sample Douglas-fir tussock moth larvae. U.S. Dep. Agric., Agric. Handb. 547. 15p.
- Mason, R.R., B.E. Wickman, H.G. Paul
1989. Sampling western spruce budworm by counting larvae on lower crown branches. Res. Note PNW-486. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 8 pp.
- Torgersen, T.R., D.C. Powell, K.P. Hosman, F.H. Schmidt
In Press, Western Spruce Budworm Populations and Host Tree Responses after Treatment with Carbaryl in Oregon: A 7-Year Analysis. West. J. Applied For.
- Torgersen, T.R., B.B. Hostetler, T.J. McConnell
In Press, Folding beating-box for dislodging foliage-dwelling arthropods. J. Econ. Entomol.
- U.S. Department of Agriculture, Forest Service, Umatilla National Forest.
1988. Western spruce budworm Meacham pilot project operations report. 259 pp.

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